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THE JOURNAL OF PHILOSOPHY

THE THEORY OF RELATIVITY AND THE FIRST PRINCIPLES OF SCIENCE

THREE questions arise with reference to the theory of relativity. They are: What is the theory? Is it valid? and What does it mean? It will be assumed in this discussion that we know what the theory is, and that the question of its validity has been answered in the affirmative. Our attention will be directed to the question of implication and interpretation solely, except as it is necessary to draw upon and modify conclusions concerning the former questions in answering it.

There is a sense, however, in which a satisfactory solution of the problem of interpretation is necessary for a conclusive answer to the problem of statement and verification. It can not be denied that much of the hesitation which certain people have, with reference to their understanding of this theory and their acceptance of its experimental validity, arises from a certain uneasiness which they feel, and can to a certain extent rationally justify, because the theory, even after one is impressed by the logically consistent and simple synthesis which it produces and the experimental confirmations to which it leads, does not fit naturally into the physical world of concrete physical objects in which we have been working since Galilei, Newton, and Dalton.

This is true and, nevertheless, there is a sense in which it is not the whole truth. For there are two points at which the theory of relativity is part and parcel of the world of concrete physics. The one is its historical origin, the other, its deductive consequences. A consideration of the theory from the point of view of its historical origin will by no means permit one to regard it as an *ad hoc* creation coming into the concrete world of the laboratory from outside.[1] It grew directly out of researches in mechanics, optics, electro-magnetics, and mathematics carried on by men like Riemann, Fresnel, Maxwell, Michelson, and Lorentz. Furthermore, the applications of the theory in physical chemistry and astronomy are evident. It comes out of the world of concrete physics, and it plays back into that concrete world. Nevertheless, it, in itself, seems in a certain

[1] A. D'Abro, *The Evolution of Scientific Thought*, Chs. X, XI, and XII. New York, 1927. J. H. Thirring, *The Ideas of the Theory of Relativity*, Chs. I, II, and III. London, 1922.

sense foreign to that world. Its origin and its consequences are not the theory itself; the theory is a set of principles which express or imply a certain conception of the nature of things. It is that conception which puzzles certain of us. It seems to leave us with a universe of mathematical relations or with something called a space-time continuum which at one moment is referred to as if it conditioned matter and its motion and at another as if it were conditioned by matter and motion. The universe, which results, seems to be devoid of a certain amount of the concreteness and discreteness which ordinary experience and the elements and materials of the laboratory would lead us to believe it possessed. Yet the perplexing thing is that this theory, which seems to set off by itself in the realm of abstract mathematical relations and general philosophical principles, arises out of and fits the concrete world more thoroughly than the more concrete theories which the imagination as well as the reason can grasp. What I am saying is that the theory of relativity, in its traditional expression, is logically but not psychologically simple.

If we lived in the Greek period of science, when it was the accepted thing to believe that nature could never be truly perceived by the senses or grasped in terms of atoms by the imagination, but could only be understood by the reason, we could understand this theory. But here in this modern world, physics rather than mathematics is the dominant science. Moreover, for three centuries the concrete masses and forces that we can touch and weigh, and the chemical and kinetic theories with their atoms and molecules, which our imagination as well as our reason can grasp, have been most productive models for scientific thought. Hence the Platonic and elusively rational aspect of this theory puzzles us and leaves us a trifle ill at ease. We hesitate to admit, and rightly, I believe, in view of the history of science before the seventeenth century, that we must give up the modern attempt to understand nature in terms of entities and laws which the senses and the imagination as well as the reason can grasp, and go back to the mathematical or functional conception of science which dominated it in the Greek period to produce the philosophy of Plato and Aristotle.

This point is not raised as an argument against the theory. That would be an entirely wrong turn to give it. As we indicated at the beginning, we are taking the validity of the theory for granted. The element of unnaturalness in the relationship between the mathematical and Platonic or Pythagorean emphasis of the theory of relativity, and the physical emphasis of it, and of such a large part of modern and extra-relativity contemporary science, is emphasized in order to indicate the significance of a question which needs to be considered. Is there not a physical basis for the philosophical

and mathematical principles of the theory itself, as well as for its origin and deductive consequences, which will enable us to grasp the universe which it represents, by the imagination as well as the reason, and thus fit it more naturally and precisely into our modern scientific outlook?

An answer to this question should clear up several points. There is, for example, the query of certain experimental physicists who ask how light can be transmitted if there is nothing to carry it. Providing that one is satisfied to give up the attempt to frame a physical model for physical phenomena, this question is beside the point and indicates a need for the person who raises it to study and understand Einstein's theory. One may reply to him that the attempt to find physical models for physical phenomena is often a useful but, on the whole, neither a necessary nor an important consideration; that the only thing of essential concern to the scientist is not the physical medium, but the mathematical law, by which light travels; and that the theory of relativity provides this. By such reasoning one may conclude that the occasion does not call for the discovery of a physical medium for light waves, but requires, instead, that our experimental inquirer change his scientific outlook.

Does this mean, however, that one is to discard an antiquated view which has been tried and found wanting for an absolutely new one which has been perfectly successful? Not in the least! Instead, it involves the rejection of a modern view for a most ancient, antiquated, and supposedly discarded one. The thesis that science is interested primarily neither in masses and forces observed by the senses, nor in electrons and ethers grasped by the imagination, but is concerned only with the mathematical principles which these physical models partially and imperfectly represent, was the dominant view of Greek inorganic science. It is, in short, the conception of the Greek mathematicians and philosophers, Pythagoras and Plato, from which, we have been telling ourselves for the last three centuries, it was such a blessing to have escaped. One must, indeed, have a little sympathy for our inquiring experimentalist, if after being drilled into certain habits of thought by three centuries of preaching of the physical and mechanical view of natural processes, he finds it difficult to completely reverse his procedure and embrace what he has been taught to believe is the enemy. The point is that there seems to be as much, if not more, evidence, even to-day, for the physical theory, in spite of its partial apparent breakdown in space-time theory and in quantum theory than for the purely conceptional and mathematical view of things. It is true that in certain instances the physical theory is developed first, in others the mathematical. These circumstances do not prove, however, that he

who asks for a physical model for a mathematical theory is without justification.

The other point, which is to be kept in mind in asking whether there is not a physical meaning for the fundamental principles which are expressed in mathematical terms in the theory of relativity, involves a more philosophical consideration. The work of Eddington, Weyl, and Whitehead suggests that the consequence of the theory is to necessitate the shifting of the outlook and foundations of science from the physical and atomic philosophy of nature which has dominated western thought since Galilei, Newton, and Dalton to either the Platonic or Aristotelian philosophy of Greek and medieval science. We know to-day how impossible it was in the seventeenth century for people to realize the tremendous change in the course of western civilization which the physical and mechanical philosophy of Galilei and Newton was to inaugurate. If the claims of Eddington, Weyl, and Whitehead are correct, it may well be that the theory of relativity will have as its consequence the turning of the main current of human interest into channels as different from those of the last three centuries as the modern period is different from the Greek or medieval. Certainly, if the mathematical conception of science replaces the physical one, it will be inevitable that mathematics rather than physics will become the dominant science in the centuries immediately ahead, that deduction rather than induction will tend to become the dominant scientific technique, and that theology supported by science, with its thesis that nature is a system of rational relations implying a mind, will tend to become a significant human concern. Is it to be a consequence of the theory of relativity to reveal for that line of thought which represents the course of western civilization, as it has for the straight line of the space-time universe, that it is possessed of a Riemannian circular property. If so, instead of taking us further and further away from the Greeks and Scholastics, contemporary scientific thought may be leading us back to them. An affirmative answer seems to be quite within the realm of probability as the writings of Eddington and Whitehead indicate, unless we can find a physical meaning for the purely mathematical essence of the theory of relativity. Even then, however, the significance of the rational and purely mathematical in nature, which the theory has revealed, indicates that a physical theory of nature, if there is one, will be very much closer to Greek scientific thought than our traditional physical theory has been.

It is evident, therefore, that there is need for a continuation of those studies, initiated by Eddington, Weyl, and Whitehead, and also by Einstein in his theory of the finite universe, which aim to express the meaning of the theory of relativity in terms of our conception of scientific law and of the nature of things.

It is because their analyses seem to be incomplete or inadequate in certain respects that the question concerning the physical meaning of the theory of relativity is raised. In this hesitation to accept immediately the Platonic or Aristotelian interpretations which Eddington, Weyl, and Whitehead have developed with such fruitful and stimulating effect upon our scientific and philosophical thought, I believe, that I am in accord with the author of the theory who has rejected the development which they follow [2] and who has been one of the few to insist upon a strictly physical interpretation.

There are three senses in which this is true. The first appears when he defines space and time in terms of coincidences between physical objects. He says: "All space-time verifications invariably amount to a determination of space-time coincidences. . . . Moreover, the results of our measurings are nothing but verifications of such meetings of the material points of our measuring instruments with other material points, coincidences between the hands of a clock and points on the clock dial and observed point events happening at the same place at the same time." [3] The second sense in which Einstein holds to a physical theory of space-time appears in the general theory when he is led to the conclusion that physical gravitational forces "define the metrical properties of the space measured." [4] The third appears in his generalization beyond the general theory in which he says: "In a consistent theory of relativity there can be no inertia *relatively to 'space,'* but only an inertia of masses *relatively to one another.*" [5] This clearly involves the thesis, as Whittaker has said, that "the metric of space-time may be determined *wholly* by the masses and energy present in the universe, so that space-time can not exist at all except in so far as it is due to the existence of matter." [6]

The question which we are raising may be put, therefore, in more explicit form. Must the space-time continuum of the general theory be defined in terms of matter? Many will be inclined to answer in the affirmative, and to point to the fact that Einstein has done precisely this in his generalization beyond the general theory to his theory of the cylindrical universe.[7] There are three considerations which suggest that the question is not so easily dismissed. One is the group of difficulties which have been emphasized by Eddington, Weyl, and Whitehead; another, certain facts which stand

[2] A. Einstein, *Math. Annalen*, Vol. 97, p. 100.

[3] A. Einstein, *Principle of Relativity*, Methuen, 1923, p. 117.

[4] Einstein, *ibid.*, p. 120.

[5] Einstein, *ibid.*, p. 180.

[6] Whittaker, *Science*, Vol. LXVI, No. 1706, p. 228.

[7] "Cosmological Consideration on the General Theory of Relativity," A. Einstein: *Principle of Relativity*, p. 175 ff.

out quite clearly when one considers the general theory, particularly, with reference to its historical origin; and the third is the fact that Einstein's theory of the cylindrical universe, in its present form at least, is as difficult to grasp by the imagination and relate to our traditional and contemporary atomic theory as the more mathematical theories of Eddington and Weyl. An adequate answer must go one step further. We may put it in this way. Even assuming that the difficulties raised by Weyl, Eddington, and Whitehead can be met by Einstein in his generalization beyond the general theory and that it can be accepted that the space-time continuum is definable in terms of matter, the question remains concerning the particular conception of matter we are to hold. Is matter continuous or atomic? If it is atomic, it certainly can not be conceived in terms of the traditional atomic theory. Otherwise, we should have a psychologically simple conception of the theory of relativity by merely picturing in our imagination the kind of universe which the traditional physical atomic theory involves. Furthermore, Einstein's attempt at a physical interpretation leads to a finite universe. The traditional physical theory presupposes an infinite one. It can not be taken for granted that a finite universe can be reconciled with a physical theory of nature without certain rather radical modifications in that theory. In addition, it seems to be quite evident that the theory of relativity indicates a unifying relational principle which the traditional physical atomic theory does not provide. The suggestion of Eddington, Einstein, and others that we are to look to quantum dynamics for a solution of this difficulty also seems to be inadequate. Recent researches in that field have indicated the same presence of a relatedness and structure requiring us to go beyond a purely physical to a partially, if not completely, mathematical theory [8] which the space-time problem involves. The quantum theory, instead of being in a position to provide a physical meaning for the theory of relativity, seems to be calling for help upon precisely the same point. In short, whether we consider the universe in its macroscopic aspect as revealed in space-time theory, or in its microscopic details as expressed in modern atomic theory, or one may add, mid-way between these two extremes in the living organism, we find ourselves face to face with an organization or a relational factor which the traditional physical theory of discrete particles is incompetent to express. This is the reason why, notwithstanding Einstein's theory of the cylindrical universe, we find it so difficult to fit the theory of relativity into our traditional physical outlook. The traditional physical atomic theory does not have within it the deductive fertility to give rise to the elements of struc-

[8] See paper by Prof. W. F. G. Swann entitled "The New Quantum Dynamics," read before Amer. Assoc. for Advancement of Sc., Philadelphia, 1926.

ture and relatedness which contemporary scientific analysis has revealed.

If it be maintained, therefore, that Einstein has demonstrated the possibility of defining space-time in terms of matter, the question still remains concerning the particular theory of matter which it involves. It seems to require more than the traditional one. It follows that an adequate treatment of the problem concerning the meaning of the theory of relativity must answer two questions. Firstly, does the theory possess or presuppose a physical interpretation? Secondly, what specific modification, if any, in our traditional atomic theory must be made to provide such an interpretation?

In asking whether the theory of relativity is a physical theory we raise the question concerning the relation between space-time and matter. To this question there are three possible answers. One is that space-time must be completely defined in terms of matter. This is Einstein's position. The second is that matter must be defined in terms of space-time. This is Eddington's theory.[9] The third is that there is both space-time and matter. Weyl and Whitehead agree upon this. The differences between their theories need not concern us now.

That, in terms of which everything else is defined, we shall call ultimate. Since space-time when considered as an ultimate factor can only be made explicit in terms of mathematical principles, to define matter in terms of space-time is to reduce physics to geometry, and to maintain that the ultimate in nature is not physical, but rational. This was the dominant philosophy of science of the Greek period. It is uniquely designated by the principle that the real is rational. This principle asserts that the ultimate in nature, which is independent of the observer and his relation to it, is not a group of atoms or objects which can be grasped by the imagination, or perceived by the senses, but a system of purely rational, and hence mathematical, relations which can only be conceived by the reason. From this it follows that masses and forces are purely psychological appearances resulting from an interaction between the observer and the eternal, changeless mathematical relations which are their condition. In the words of Plato, the world of change, the world of sensation, is a world of shadows, the world of eternal logical forms is the real world; in the words of Eddington[10] the circular system of logical connections, which joins matter, mass, potential, etc., to each other is the absolute fact of modern physics, whereas the physical categories which we have taken for the ultimate thing are but transient terms in this relational system.

Since logical connections and systems of mathematical relations

[9] A. S. Eddington, *Space, Time and Gravitation*, Cambridge, 1921, p. 197.
[10] *Religion and Reality*, Macmillan, p. 205.

are changeless things, to define matter in terms of space-time is to hold, not merely that the real is rational, but also that it is changeless. This latter fact, which is as true for a physical as for a mathematical or for a Platonic theory of science, the Greeks designated by the principle of being. This principle affirms that whatever it is that constitutes the nature of things does not change its properties. It amounts, in other words, to the assertion that time introduces nothing new with reference to the properties of the real. It is the basis, therefore, of the principle of mechanical causation. For this latter principle affirms that a given effect can be traced back to present or past conditions, or that knowing the present conditions one can predict all future states. This can be true only if time introduces nothing new with reference to the properties of the ultimate causes; or, in other words, if the principle of being holds. Therefore, to be a mechanist, is to assert the principle of being.

It is to be noted that the physical and mathematical or Platonic theories of science agree in accepting the principle of being. The ultimate physical atoms, like mathematical laws, are eternal changeless elements. Both theories are, therefore, mechanical. One can predict as well in Platonic science as in physical science, as the astronomy of Eudoxus or the tensor equation for gravitation indicates. The mathematical and physical theories are both mechanical; they differ only in their second principle concerning what it is that constitutes the real, the former asserting that it is rational, the latter that it is physical. Therefore, to hold that space-time is definable in terms of matter is to assert the principle of being and the principle that being is physical; to maintain that matter is definable in terms of space-time is to assert the principle of being and the principle that being is rational. The former is the physical and mechanical philosophy of modern science; the latter, the mathematical, mechanical, and Platonic philosophy of Greek inorganic science. The issue between Eddington and Einstein involves nothing less, therefore, than the question concerning whether the theory of relativity necessitates the shifting of the structure of science from the physical foundations upon which it has rested since the seventeenth century to the rational, mathematical, and Platonic foundations upon which it rested in the Greek period. Is that in our universe which is independent of the particular place where a scientist happens to stand when he observes natural phenomena so purely rational and relational that it can only be grasped by pure mathematicians? If matter must be defined in terms of space-time we must answer in the affirmative and regard Plato as a scientist with sounder insight than either Galilei, Newton, or Dalton. If not, then the theory of relativity can fit into our modern

outlook and should find its meaning in terms of objects that ordinary mortals, as well as pure mathematicians, can grasp.

But there is another alternative. Perhaps neither is completely definable in terms of the other. Both space-time and matter may be conditions of natural phenomena. This position, held by Weyl and Whitehead, amounts to the assertion that there is in nature both matter and form. Hence, it involves a return to Aristotelianism.

We are now able to state, in more general terms, the problem concerning the relation between space-time and matter, which is raised by the theory of relativity. It is the problem of the relation between things and their relations. Do things reduce to relations, do relations reduce to the properties of things, or are there both things and relations? The first alternative is the Platonic mathematical theory of nature, the second, the physical atomic theory, and the third, Aristotelianism.

We thought Galilei, Newton, and Dalton answered this question once and for all in favor of the physical theory of nature. The theory of relativity has indicated, however, that their answer is not as decisive as we supposed. This, as much as any particular addition which it has made to technical physics, is its great significance. It has cut down beneath the presuppositions of modern science into that question concerning the relation between things and their relations which is the timeless theme of all science, be it Greek, medieval, or modern. For the first time since the seventeenth century the first principles of science are in question, and the issue between Platonism, Aristotelianism, and the physical theory, which during the last three centuries has been of interest only to philosophers, now becomes of concern to physicists as well. This is significant for both philosophers and physicists. For the former, it means that contemporary physics may provide a means of putting a fundamental issue of philosophy to an experimental test. For the physicists, it means that careful consideration of the fundamental principles of Greek philosophy and their consequences may enable one to infer, from the facts of contemporary physics, conclusions which the facts alone might not suggest. It follows, also, that an adequate treatment of the meaning of the theory of relativity requires that we view it in a scientific background very much broader than that of the last three centuries.

It will be worth our while, therefore, before we turn to an analysis of the theory of relativity itself, to determine the principles of the three major theories of science, and their respective consequences. We do not propose to solve the problem in relativity physics by such an analysis, but merely to discover a set of hypothetical propositions asserting the consequences of certain possible positions, which will

enable us later, if facts in physics permit us to assert the antecedent of one of these propositions, to also assert its consequent. Thus, by bringing established hypothetical propositions of philosophy to bear upon the facts of physics, we may be able to reach conclusions which the facts alone might not suggest. Certainly, the problem which divides Einstein, Eddington, Weyl, and Whitehead is sufficiently difficult to warrant all the aid we can get, and there is no sense in standing helplessly before it in disagreement when principles already known, but outside the modern tradition, may help us to solve it.

It remains for us to add but one principle to those which we have already stated in order to have before us all the principles sufficient to define the mathematical, physical, and organic theories of science. This principle is the principle of becoming. It asserts that the properties of the real, change. In other words, it asserts that time introduces something essentially new in the properties of the first causes. From this it follows that the future is not entirely determined by the present, and, hence, that mechanism is not valid. Therefore, if the principle of becoming holds, the principle of teleology is also true. For to assert that time introduces something new in the properties of the real is to maintain that future and final as well as past or present factors determine the course of nature in its passage from what it is now to what it is going to be. This explains why Aristotle, who accepted the principle of becoming, was a teleologist.

The four fundamental principles, in terms of which any one of the three possible theories of science can be defined, are now before us. They are the principle of being, the principle of becoming, the principle that the real is physical, and the principle that the real is rational. To assert the principle of being and the principle that the real is rational is to hold to the mathematical or Platonic theory of science; to assert the principle of being and that being is physical is to hold to the physical theory of science; and to maintain that the real is becoming is to hold to an "event" or emergent or Aristotelian theory of science. The first two theories are mechanical; the latter, teleological.

It is necessary to indicate how the Aristotelian theory that nature is matter and form, or in its contemporary statement, matter and space-time relatedness, necessitates the principle that the real is something that changes its properties,—a process or "event," and not a collection of atoms or a system of relations. The reason is that, if matter satisfies the principle of being, there is no meaning to a relation apart from the properties of the thing related. A law is not an additional metaphysical entity standing over against matter and forcing it by some mysterious means to move in certain ways; it is

a mere statement of how matter does move and relate itself as a result of its changeless properties. Aristotle clearly perceived this when he asserted that there is no meaning to form apart from individual things which exhibit form. Since this is so, but two alternatives are available. Either, one must assert, as do the materialists, when they are consistent, that all relations reduce to the properties of things, or one must regard relations or form as a characteristic of something else of which matter is another characteristic. The latter alternative enables one to maintain that form is a characteristic of something which exhibits form, and to escape the conclusion that all form or relatedness must be defined in terms of matter. This makes both matter and form passive characteristics of something else. If change is real this "something else" must change its properties with time. Otherwise, nature would be a static and not a dynamic system. Hence, the admission of both matter and space-time as irreducible, the one to the other, necessitates the thesis that the real is becoming,—an "event" or process which changes its characteristics, and not an entity, either physical or mathematical, with fixed properties. Since space-time relatedness applies to the whole of nature and not merely to its parts, it follows, if the fallacy of regarding relatedness as a metaphysical thing-in-itself is to be avoided, that nature must be a single process and not a group of processes. The relation which joins the parts of the process together to form the whole turns "individual things" into aspects of the process of the whole just as the form of a local isolated system turns the matter of that system into a characteristic of a process of becoming. This does not appear in Aristotle's philosophy because his desire to regard particular individual things as real prevented him from carrying his thesis that forms are meaningless apart from things, through to its logical monistic consequences. It comes out clearly, however, in Whitehead's theory of events when he maintains that the only statement about nature which does not oversimplify it and hence falsify it, is a statement about the whole of fact, to the effect that nature is "something going on now." Strictly speaking, according to his and any consistent philosophy of becoming which admits structure in the whole of nature as well as in its parts, there is only one process or "event" in nature. It must never be forgotten, therefore, that the attempt to solve the problem concerning the relation between space-time and matter by refusing to define either in terms of the other, is not to keep electrons and protons and space-time, but to lose both as ultimate causes. They must be regarded as passive, relational, and adjectival characteristics which repeat themselves in a monistic teleological process of change. Electrons preserve their individuality only in the mind of the

thinker, due to an over-simplified abstraction which he makes; never, in "the concrete passage of nature."

The result of this analysis may be stated in terms of two hypothetical principles.

> (1) If the theory of relativity is a physical theory then space-time must be defined in terms of the relations to which the properties and motion of physical things give rise.
>
> (2) If space-time is even partially indefinable in terms of matter then either (*a*) matter must be defined completely in terms of space-time, or (*b*) nature is a monistic process of becoming in which objects and space-time are mere passive adjectival and relational appearances.

The relation of the mathematical and the physical theories of science to the fact of change is equally important. Strictly speaking, to define matter in terms of an irreducible continuum is to define it in terms of the one; and to define it in terms of a space-time or mathematical continuum (since relations which depend on nothing else are changeless things) is to regard the one as changeless and hence as satisfying the principle of being. From this it follows that change must be unreal, i.e., it must be a relation between the observer and the object and not a characteristic of the object. This Plato clearly perceived when, in formulating the first mathematical theory of science, he said that the real is changeless, eternal, and immutable. Parmenides' proof that change is unreal, if the real is one and is being, is simple. Either change is due to generation or to motion. It can not be due to generation, since that is contrary to our hypothesis that the real is being. Neither can it be due to motion, for in order that one thing may move, it must move from where it is to where it is not, and this is impossible if there is nothing but the one. A third hypothetical principle is now available for our use.

> (3) If matter is definable in terms of an ultimate continuum, and this continuum is a system of mathematical relations, then all change is unreal.

The relation of the fact of change in nature to a physical theory of science is so important in connection with Weyl's and Whitehead's objections to the theory of motion in Einstein's physical theory, that an account of Greek thought upon this point is essential. It was the difficulty over accounting for change in a physical theory of science that led to the introduction of absolute space. Anyone who attempts to give the theory of relativity a physical interpretation after it has removed the notion of absolute space, is inviting trouble, therefore, unless he is thoroughly aware of the difficulties over reconciling matter with change which the Greeks clearly perceived.

The first fact which they noted was that this is a universe of

stuff. This commonplace fact is the basis of the physical theory of nature. This fact, we have stated in terms of the principle that the real is physical. They noted also that the main characteristic of stuff is permanence. Hence, they went on to lay down the second principle in a physical theory, to the effect that the real is being.

Immediately, a difficulty arose. If stuff is being, how can change be real? Parmenides demonstrated that it can not be real if reality is conceived to be only one substance or many atoms. The proof is valid. He argued that change must be due either to generation or to motion. If the real is being it can not be due to generation. Therefore, it must be due to motion. But it can not be due to motion, for there is no meaning to the motion of anything unless that relative to which it is moving is specified. This is impossible if the real is one. Therefore, stuff must be many, but this is impossible if the real is physical and stuff is nothing but microscopic particles, since, in order that there be particles there must be something to go between them, which is impossible if they are all that exist, and in order that change be real they must move relatively to something else, which is impossible for the same reason. Therefore, Parmenides concluded that the fact of stuff plus the laws of logic force one to hold that nature is one single changeless eternal substance and that change is an illusion. Heraclitus took the other alternative, by holding to the fact of change, emphasizing the constancy of the law exhibited in the process of change, and denying the primacy of the physical.

Logic seemed to require that one choose between two theories, either one of which necessitated the denial of a certain fact. In other words, nature, when carefully observed, revealed two facts which contradicted each other. This is exactly analogous to the situation which Einstein faced when he noted the principle of relativity and the principle of the absolute velocity of light to be valid, and yet contradictory, in the electro-magnetics of Lorentz. Furthermore, the Greeks met their contradiction with the same sound logical procedure that Einstein used in meeting his. They argued that since stuff and change are both facts and nevertheless contradict each other, therefore, the unproved assumption upon which the contradiction rests, to the effect that nature is only one substance or many atoms, must be replaced by the principle which makes both facts true without contradiction. This principle is that nature is a group of atoms separated by and in motion relative to something else. Just as Einstein argued from two apparently contradictory facts to the relativity theory, so the Greek philosophers, who followed Parmenides, argued to the atomic theory.

Nature is not mere stuff, conceived either as one or many, but is a group of atoms separated by and in motion relative to something else. This "something else" the Greeks called absolute space. Thus, at its very inception, the physical theory was forced to a theory of absolute space in order to reconcile itself with the fact of change. This point has not received the attention it deserves from those who hold that the theory of relativity is a physical theory. How there can be any meaning for motion in a physical theory, now that absolute space is rejected, has not been made clear.

Two points must be noted. In the first place, an atomic theory is useless unless it is a kinetic atomic theory. The only reason for regarding matter as atomic, is to account for change, and this is impossible unless the atoms are in motion. This fact we can state in terms of another hypothetical principle.

> (4) If the theory of relativity is a physical theory and change is real, it must be a kinetic atomic theory.

In the second place, it is to be noted that our statement of the proof of the atomic theory is different from the one which the Greeks gave. They argued that the facts of stuff and change plus logic necessitate that nature be regarded as made up of atoms in motion in absolute space; we stated that it proves merely that the atoms are separated by and in motion relative to something else. Their conclusion does not follow unless absolute space is the only possibility. This is a proposition which they did not demonstrate. This point is significant now that Einstein has removed absolute space from it suggests that perhaps the Greeks were too hasty in regarding their argument as proof of the existence of absolute space, rather than of some other referent for atomic motion. This suggests also that it may be in a new physical theory of this other entity that a physical meaning for the theory of relativity is to be found.[11] At the present stage of our analysis this, however, is mere conjecture. The certain thing which we can write down is that

> (5) If the theory of relativity is a physical theory and change is real there must be something other than the microscopic particles in which and relative to which they are moving.

If space-time is defined in terms of matter it is not clear what this referent for motion can be. This is one basis of Whitehead's and Weyl's objection to Einstein's attempt to define space-time in terms of matter.

It is to be emphasized that this difficulty can not be met by substituting space-time for absolute space. For, as our first and fourth hypothetical principles indicate, if the physical theory is to be justi-

fied, motion must be presupposed in defining space-time. A vicious circle would result, therefore, if space-time were introduced to provide a meaning for motion.

A thorough discussion of this point must wait, however, for an analysis of the theory itself. In such an analysis these five hypothetical propositions must be kept in mind. They permit us to assert the respective consequent, when the antecedent of any one of them is confirmed by any contemporary fact of relativity physics.

Three main points will serve to emphasize and summarize the essential considerations which are expressed in these five principles. (1) If the theory of relativity is a physical theory and if change is a physical and not a purely psychological fact, then space-time must find its meaning in terms of a kinetic atomic theory, and some entity, replacing absolute space, must be introduced to provide a meaning for atomicity and motion. (2) If matter must be defined in terms of space-time then physical change is unreal. (3) If there is both matter and space-time, irreducible the one to the other, then the modern conception of electrons and protons as individual things out of which nature is constituted must be rejected, and replaced by a statement of the facts and laws of physics and mathematics in terms of nature conceived of as an essentially unanalyzable and indivisible process of change in which certain structural attributes called space-time and certain adjectival characteristics called objects exhibit themselves as standing in many terms relations to each other and the whole.

It remains for nature, as revealed through Einstein's experimentally verified theory, to tell us which of these alternatives is true. A study of the theory itself, its implications and presuppositions, with particular reference to the problem of the relation between space-time and matter, should decide this question.[11]

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KALLEN'S CRITICISM: A REPLY

IN Mr. Kallen's review of my *Wrestle of Religion with Truth*[1] he writes that he can not join issue with me in the criticism I make of his own book because I misunderstand him. After reading his review I conclude that our misunderstanding must be reciprocal and amazingly complete. I shall not, then, "join issue" with him; but it may be of some value to try to clarify one or two points involved in his criticism.

[11] See article entitled "The Macroscopic Atomic Theory: a Physical Interpretation of the Theory of Relativity" in next issue of this JOURNAL.

[1] This JOURNAL, Vol. XXV, pp. 273–278 (May 10, 1928).

Apart from his attack on Whitehead Mr. Kallen's chief points of criticism seem to be two. One is my alleged attempt to make religion "scientific" with consequent "obfuscation" of religion and distortion of scientific method. The other is my serious mistake of trying to base religion upon an experience of "ultimate substance." When certain distinctions under these two headings are made plain his criticisms will be found, I think, to be beside the mark.

Scientific method is a term which has two different meanings in current usage. Sometimes it means in general the method of observation, analysis, inference, and experiment. Its narrower and stricter meaning, however, is the peculiar refinement and limitation imposed upon observation, analysis, inference, and experiment when these are brought under the control of mathematical formulas and mechanical instruments. It may be that the latter only is deserving of the title of scientific method, but nothing is more unprofitable than to dispute what is the proper usage when people do in fact use a word with both a broader and a narrower meaning. I make it very plain in the book under discussion that it is absurd to try to make religion scientific in the sense of subjecting its beliefs and practices to the control of scientific method in the second of the two meanings of that term. With that understanding of "scientific," religion can never be made scientific any more than friendship or politics or morality or cultural education of youth, because these interests involve problems which are not amenable to the technique of the exact sciences.

But the method of observation, analysis, inference, and experiment can be used in some rough manner in friendship, politics, and morality, for that means merely to be intelligent in the prosecution of these interests. This *is* the method of intelligence. Intelligence, to be sure, is rarely exercised in its purity, even in the exact sciences, because of the admixture of "blind" traditionalism, routine habit, wild guesses, fantastic constructions of imagination, obsessions, etc. But the method of intelligence is the only alternative to slavish conformity and fantastic wildness.

My only claim for religion is that it also should be subjected to the method of intelligence. If this means "making it scientific," well and good. If this means not making it scientific, also well and good. But there are many exceedingly important problems in friendship, love and marriage, morality, politics and religion, which can not so much as be considered by any of the exact sciences. To adore science in the sense of the exact sciences, as the way to all knowledge, the means to all mastery, and the panacea for all ills, is to misunderstand most egregiously the scope and nature of strict scientific method.

Mr. Kallen implies in his review that the method of retiring to solitude, meditating, acquiring insight, and testing that insight by the adventures of living is somehow foolish and futile. He writes that it "characterizes itself in its own summing up . . . adds to the current obfuscation and obscurantism by befogging such clear and distinct ideas as it [religion] has." Does Mr. Kallen mean that this is not the scientific method in the narrow sense? Then he is certainly right and I have nowhere suggested anything to the contrary. But does he mean to claim that the most difficult and complex problems of human living never require one to meditate and acquire insight and test that insight by the adventure of living? Apparently that is precisely what he is saying. Must we, then, not conclude that his statement "characterizes itself in its own summing up"?

Another set of terms found in my book, which are very disturbing to Mr. Kallen, are "ultimate cause," "supreme good," and substance. Only in two chapters do I make use of these terms and then solely for the purpose of meeting in controversy certain views which are sometimes couched in such language. As matter of fact I wrote those two chapters after listening to a lecture by one of the leading philosophers of the United States who discussed religion in terms of "ultimate cause" and "supreme good," presenting a view I could not accept. I used his language to combat his position. I fear Mr. Kallen is under misapprehension when he feels that his own book was the chief matter of concern in one of these two chapters.

The concept of substance plays an insignificant rôle in my discussion of religion. I use the term incidentally and without any of that connotation which Mr. Kallen reads into it. He fails to note the context in which it occurs, which gives it a different significance from what he attributes to it. In the book I show that a certain kind of mystical experience involves the disorganization of habits without loss of consciousness and that it is therefore a state in which one experiences the substance or content out of which divers worlds might be constructed, but which is not itself a world. All I mean by this is that a man's habits constitute one of the factors determining the kind of world in which he lives. When his habits are disorganized this determining condition of an articulate world is removed. Hence he has no articulate world, but he has that content of experience out of which different worlds may emerge according as he develops out of this disorganization one set of habits or another. This confused inarticulate state of the mystic's consciousness is an experience of substance merely in the sense that out of it different worlds may be constructed according to the kind of habits acquired.

Mr. Kallen errs when he thinks that I identify God throughout with the "substance" which the mystic experiences. God can be so conceived and often has been; but all I say is: "If God be defined as the object of this mystic experience," certain consequences follow. In another place I also indicate what would follow if God be so considered. But that is not the way I define the concept of God throughout the book; and these are the only two cases, I believe, where I give this thought any consideration.

When the *New Republic* asked me to review Mr. Kallen's *Why Religion* some time ago I was glad to have the opportunity, for I had always been stimulated by his brilliant writings. But the contents of the book and my review of it reveal why his disagreement with me is so emphatic. If my view of religion should be correct, his own religious experience would take on a wholly different character from what he attributes to it. He attained this experience by submitting to long discipline under the direction of an expert yogi—or rather two of them. He believes that in this experience he had immediate access to the supernatural, which is a "mode of vibrant energy" breaking in upon us occasionally with "truly saving power." I have a wholly different account to give of the kind of experience he has in mind.

While I can scarcely expect that Mr. Kallen and I will agree upon the matter of religion when our backgrounds are so radically different, I do hope that we may come to a better understanding of one another.

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BOOK REVIEWS

Principia Mathematica. ALFRED NORTH WHITEHEAD and BERTRAND RUSSELL. Second Edition. Cambridge, at the University Press; and New York: The Macmillan Company. Vol. I (1925). Pp. xlvi + 674. Vol. II (1927). Pp. xxxi + 742. Vol. III (1927). Pp. viii + 491.

When this great treatise first came out, with its pages that look something like hen-tracks on the barnyard snow of a winter morning, there were those who accused the authors of trying to conceal the secrets of the universe under an incomprehensible hieroglyphic cipher, and who said that the universe itself was more comprehensible than was this book about it. But we who did seriously try to read it, and succeeded without much trouble, for its language is very simple for those who try—we knew how silly such opinions were. We came rather to like the language, with its p's and q's, and its

phi-x-caps and *R-backward-arrows,* and *existences-with-a-shriek,* and *existences-upside-down,* and so on, even up to the mysterious generalization called the *female-relation,* and the hypothetical majesty of *Aleph-sub-zero.* We tried catching one another on such puzzlers as, "What is the difference between *limax* and *multax?*" But no one is competent to criticize the *Principia* philosophically who could not rewrite its statements in another symbolism, or think back of the symbolism the meanings which are there expressed. And one who can do this will have no illusions about the finality of the work, or its world-inclusiveness. It is true that this is a study of the foundations of mathematics, which arrives, in this edition, at the number *one* after 392 pages, and at the *multiplication table* after 852 pages. And it is not merely a great work in bulk, but also a great work in labor expended, in ability, and in ingenuity. But it is not a work of metaphysics.

The history of the critical examination into the foundations of mathematics, an examination of which this work is one of the great landmarks, is a history which ought, in its general outlines, to be fairly familiar to all philosophers. On the one hand there was the collapse of what seemed solidly established regions of mathematics. On the other there was a demand almost amounting to an ethical imperative for the utmost of mathematical rigor, a demand which is still insistent and perhaps still not fully realized. I for one shall never forget how Professor Royce used to phrase this, as an imperative imposed by the mathematician's intellectual self-respect, and his loyalty to truth and precision. Through the nineteenth century the whole structure of mathematical science was reviewed from this standpoint, with an austerity of scrupulous care which admitted no compromise. It was shown that certain mathematical objects, such as infinitesimals, which had been held by the philosophers as a standing reproach against mathematics, could be dispensed with altogether. While in metrical geometry there were quantities, such as a unit of space length, which could not be deduced from anything simpler, the assumption of one such unit was found to be enough, and all the rest of geometrical structure could be handled by methods of projective geometry, as being cases of order and arrangement. So mathematics came to be looked upon as the science of groups and orders, rather than the science of quantity. Its application to quantity was incidental, and chiefly of note because quantities could be so readily ordered.

Furthermore, the non-Euclidean geometries showed that internally consistent mathematical systems could be built up from a variety of opposing starting points, some of which were by no means self-evidently true. The self-evidence of axioms was still

further shaken by examples of what seemed self-evidence which turned out to be definitely false, as in the supposed axiom that every continuous curve has tangents. So mathematicians grew wary of self-evidence, and began to speak of the assumptions, or postulates, of a mathematical system, rather than of its axioms, and often the most fertile, or most simple, assumptions were found to be by no means the most self-evident.

But above and beyond all this there was a steady process of unification, the arithmetization of all mathematics. As a result of this process of unification, it was shown that the validity of the deductions of all the higher branches of mathematics depends upon, and may be justified by, the validity of the deductions of simple arithmetic. Hence simple arithmetic became the key to all mathematics. Could it itself be deduced from anything more fundamental?

Kant seems to have held that each arithmetical truth is a separate synthetic judgment, as two plus three equals five. Whether we call them synthetic, depends perhaps on our use of terms, for there is a sense, though Mr. Russell appears to wish to deny this, in which all deduction is synthetic. But that the truths of arithmetic are separate and isolated seems definitely false. To find any connection, however, means to analyze back to some more fundamental relations, which being pre-arithmetical, we may speak of as "purely logical." The technique for carrying out such investigations has been the so-called symbolic logic, which was first developed by Boole with the intention of using mathematical methods in logic. It was inverted by some later investigators, such as Peano and Frege, with the intention of reducing mathematics to logic, and the *Principia Mathematica* before us is the culmination of this movement. Of course, there are other symbolic logicians who are not at all interested in mathematics, but in developing a symbolism for the easy handling of complex combinations of ordinary premises in reasoning. This is a totally different aim, and calls perhaps for a different technique and symbolism.

Two comments immediately present themselves concerning the mathematical evolution. The process of development has been moving backwards, from higher mathematics till it has reached arithmetic and then logic. Hence there may be a sense in which the deductions are surer than the first premises. And also the *Principia* really is not a work that goes back to the ultimate foundations. It begins somewhere in the middle, postulating a system of logic which perhaps is not yet fully developed, and developing not logic, but the link between logic and ordinary mathematics. Hence its first pages are decidedly tentative, and even intentionally temporary.

Secondly, it might be asked whether this starting point should

be called by the old name "logic." Though it deals with the conditions of formal validity, with precisely that which is supposed to differentiate deductive logic from the psychology of thinking, it as certainly does not deal with thinking as a process, but rather with a subject-matter as objective as is mathematics itself. I am disposed to believe that Messrs. Whitehead and Russell would do well, on the basis of their own theory of types, to distinguish more clearly between "logic" and the propositions they utter about "logic." The difficulty is rendered very grave by the fact that one's symbolism has itself a logical structure, and that it may play you tricks by having a structure different from the structure you are trying to talk about. I have long ago given up hope of finding out precisely what Mr. Russell now means by the term "proposition." Certainly it can not be intended that all mathematics can be deduced from a science about symbols, instead of from a science that uses symbols to deal with its highly general subject-matter. Regarding the name "logic," I regret that the biologists long ago appropriated the name "morphology," while the term "logistic" is inaccurate, as applying only to the symbols and their technical manipulation, as well as being one to which the military men have put in some claim. About all we can really do about it is to distinguish between "structural logic" and "noetic logic."

Is it necessary that philosophers should know about this structural logic? Some there are who say they have examined it, and found nothing there. If most of these people did not make such stupid errors, which a knowledge of this subject ought to prevent, I should be more inclined to grant their contention. But I have no wish to limit philosophers by saying that there is anything that they really have to know before they begin to philosophize. All I should claim is, that I doubt if ignorance of the *Principia* is really a merit in a philosopher. Yet certainly, except at Harvard, where the tradition which Professor Royce and Mr. Russell himself started has been ably carried on by Messrs. Sheffer and Lewis, it seems hardly to attract any attention in this country. I used to lecture on this sort of logic elsewhere myself, employing ordinary language, and leaving the symbols aside until students had grasped the general ideas, and had come to feel the need of symbols for the sake of simplicity, clearness, and saving of time. It was a pretty hopeless task. I drew some interested mathematicians, and a few stragglers from the philosophy department. I remember one student, a philosophy student of real ability, who arrived the first day with a large notebook. After listening for a while, he interrupted with a puzzled question, "But this subject which you call 'logic'—what has it to do with Professor Dewey's 'logic'?" I answered, perhaps with

too much asperity, "It has nothing whatever to do with Professor Dewey's 'logic.'" "Well, then, I do not see any reason for staying here any longer," he said, as he tucked his notebook under his arm, and disappeared out the door, nor did I ever see him again.

In a review like this I can hardly undertake to present enough of the subject of these great volumes even to bring out some points on which I should like more enlightenment. Since conditions compelled me to turn to other things, I doubt if I am any longer particularly competent in these questions. Yet I think a little further comment may be of use. In this edition, the third volume is reprinted, and the other two corrected and reset upon a somewhat larger page, with some additions, especially as outlined in a new introduction. The work of Dr. Sheffer is given very high praise, and the chief additions are references to the work of Sheffer and Nicod, and some further wrestling with the awkward "axiom of reducibility." From Sheffer's "stroke-relation," of incompatibility (not-both-true), one is able to develop "and," "or," "if-then," etc., in a way which brings out their mutual interdependence, and is as ingenious as getting rabbits out of a hat. And then one can state, in the stroke notation, Nicod's one proposition from which, once granted, all mathematics follows. This fateful proposition I may paraphrase, rather crudely and intuitively, in words as follows: "If a proposition p implies other propositions such as q, then not only does every proposition imply itself, but also any proposition inconsistent with q is inconsistent with p." From this all the propositions of all mathematics can be deduced, provided you have the brains, and the *Principia* gives the essentials of this deduction.

In this edition the distinction of real and apparent variables disappears, all being of the latter variety. In fact, variables are whatever does not vary! The symbolism is helped out by a new dictionary of definitions—or what we should ordinarily call a dictionary of abbreviations. Perhaps the worst fault of the work is that there are so many of these, yet it seems hard to avoid abbreviating, if every statement is not to cover a page, as in Frege. Doubtless historical accidents account for a goodly number of the symbols, and improvements could be made, though many objections to the symbols have been really objections to the distinctions which the symbols embody.

According to Mr. Russell, the theory of types is entirely a question of the proper use of symbols, and some sort of theory of types is necessary to avoid contradictions. Such a contradiction is that of "the class composed of those classes which are not members of themselves," which class, if it is not a member of itself, is a member of itself, and *vice versa,* if it is, it is not. Additions to the present

text investigate an alternative to the "axiom of reducibility," which axiom was called for by the problem, raised by type difficulties, of talking about *all* the characteristics of an object. The alternative is admittedly unsatisfactory. I should extend the unsatisfactoriness to the whole theory of types. I am disposed to agree that some sort of theory of types is needed. But the present one seems almost certainly too broad.

I think the theory as developed by the authors of the *Principia* is trying to meet two rather distinct sorts of fallacies. It tries to meet, for instance, such difficulties as are contained in the assertion, "This statement is false." The contradiction is here that the statement formally claims truth, like all assertions, and yet materially claims falsity, through what it says. But when this is stated in the form of the notorious Cretan's declaration, "All Cretans are always liars," it contains this fallacy compounded with another, that of illegitimate totality. This latter I do not think is due merely to the symbols used.

Such a difficulty may occur in cases wherein I can discover no puzzle about symbols. To illustrate, let us suppose, or hypothetically postulate, that a man's actions are determined by various causes, of which some are his possession of bits of relevant knowledge. The vagueness attaching to the term "cause" does not seem to me to affect the main issue of my argument, nor need we raise the question whether the assumed case is in correspondence with actual fact. Let us now suppose that the man knows all the sum of causes which are leading him to act. He will then perceive that he is about to, let us say, write a letter, owing to the concurrent action of the sum total of these causes. But being a contrary sort of person, this knowledge becomes itself a new cause, which, added to the other causes, produces an effect of refraining from writing a letter. But being a very contrary person, this in turn becomes an adequate stimulus to him to write the letter, and so on. Whichever way it is, it is the opposite. This illustration seems to me to show that the difficulty is one about the totals themselves, and not about symbols of totals. It seems further to lead to the conclusion, in accordance with the theory of types, that no part can be defined in terms of, or be caused by, the whole of which it is a part. But it may now be objected that such a simple case as a color-contrast illustrates the contrary. The blue and yellow form a whole, wherein the blue becomes bluer against the background of yellow, which makes the yellow look yellower, which makes the blue look bluer, and the senses make the sum to infinity almost instantly. How then assert that a part can never be made what it is by the whole of which it is a part? Empirical evidences, not to speak of Mr. Whitehead's own theory

about organic unities, seem to establish the possibility of the contrary. Yet contradictions due to illegitimate totalities do exist, and are so bad that whatever we say about them, affirming or denying, we equally fall into contradiction. If we deny that a class can be a member of itself, we fall into the contradiction just as if we asserted that it could. I feel the difficulties, but the theory of types seems to go too far, and throw out the baby with the bath.

But it is hard for me to argue the matter further without raising still more sweeping objections. It is laid down in the new introduction to the *Principia:* "Given all true atomic propositions, together with the fact that they are all, every other true proposition can theoretically be deduced by logical methods." Atomic propositions, it may be explained, are those like "*a* has the quality *m*," "*a* has the relation *R* to *b*," "*a*, *b*, and *c* have the triadic relation *S*," and others of like kind, containing only *one* relation, and having no reference to *all* of anything. This means or implies a number of conclusions of which I am very doubtful. I may remark that the qualifying clause, "The fact that they are all," contains something which is not an atomic proposition, but which is of great importance, and is contained in all universal propositions, and possibly in all negative ones as well. But this aside, the statement seems to amount to saying that the world is made of a set of atomic "facts" or "complexes," each containing only one quality or relation, and each referred to by one atomic proposition, if the fact and the proposition be not identical. Hence the only relation of these facts to one another is that of mutual coexistence. Hence the only systems are mere sets of coexistent, mutually independent facts. Why, then, say there are any systems? This is perhaps the reason why Mr. Russell can find no cases of Professor C. I. Lewis's relation of *strict* implication. But this is not all, for furthermore it is implied that any universal proposition is a mere sum of individual atomic propositions, alike but independent. This is perhaps the reason why Mr. Russell can find no basis for the inferences called "inductive." It implies also that any statement about possibility is reducible without remainder to a sum of atomic propositions about what actually exists. Each and all of these theorems seem to me highly dubious. And if they are not true, the problem of types is even more complex than the *Principia* represents it. Hence I shall not attempt here to argue the question further, since it involves a whole treatise on metaphysics.

But my distrust of the philosophical foundations seems to me quite compatible with a sincere admiration for the *Principia.* The puzzles that still linger will in time find their solution, or lead on to others deeper yet. But while that is going on, the most of these nearly two thousand pages will remain much as they are now. There

is a good deal that might be further explained or debated, but I close rather with a simple reaffirmation of my admiration for this giant achievement. What may have to be done over again will have to be based on what is already here.

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The Correspondence of John Locke and Edward Clarke. Edited, with a Bibliographical Study, by BENJAMIN RAND. Cambridge: Harvard University Press. 1927. Pp. xvi + 607.

John Locke had a genius for friendship. One of the closest of his intimacies was with the parliamentarian, Edward Clarke. The relationship was established at about the time, and was probably in large measure the result of Clarke's marriage with the philosopher's cousin, Mary Jepp. The young barrister was in his early twenties; Locke had already passed his fortieth year. Their friendship endured until Locke's death. Locke's complete correspondence with Clarke and his family, as here published, is an extended portrait of his genial personality.

These letters contain some additional information about the details of Locke's life. There are a few allusions to the growth of the *Essay concerning Human Understanding.* They contain the original draft of the greater part of his *Thoughts concerning Education,* which were originally written as advice to Clarke on the upbringing of his children. And there is an extensive section of the correspondence between the two men, which fully reveals the part that Locke played, through the agency of Clarke, then a member of parliament, in the enactment of the important coinage legislation of the period. All of these details are incorporated by Dr. Rand into a well-written biographical study, prefaced to the volume, of Locke and Clarke.

What information there is about the writing of the *Essay* is primarily regarding the time and mode of its composition: Locke writes from Utrecht in January, 1685, that he has devoted most of the time during the past winter to his "enquiry concerning *Humane Understanding,* a subject which I had for a good while backwards thought on by catches and set down without method several thoughts upon as they had at distinct times and on several occasions come in my way; and which I was now willing in this retreat to turn into a less confused and coherent discourse, . . . and to that purpose had brought those papers along with me to this country" (p. 117).

In the same letter Locke inquires if the Earl of Pembroke (to whom the *Essay* was dedicated) has expressed any desire to see his discourse of which one may now perceive "the design and connection

of the parts" (p. 120). In February, 1685, Clarke informs Locke that Lord Pembroke would like to see the *Essay*. An abstract was sent by Locke in May, but Clarke did not receive the fourth book of the *Essay* until December, 1686. On December 17, 1686, Locke writes that the "fourth and last book of *De Intellectu Humano* is now growing into some form" (p. 176). Two weeks later, December 31, he writes: "You have here at length the [four]th and last book of my scattered thoughts concerning the *Understanding*, and I see now more than ever that I have reason to call them scattered, since never having looked them over all together till since this last part was done, I find the ill effects of writing in patches and at distant times as this whole essay has been. . . . Of what use it may be to any other I cannot tell, but, if I flatter not myself, it has been of great help to [our first enquiry], and the search of knowledge ever since has been in my thoughts, which is now five or six years. For so long ago is it since some friends upon an accidental discourse [started me] upon this enquiry, which I am not sorry for. And if it has cost me some pains in thinking, it has rewarded me by the light I imagine I have received from it, as well as by the pleasure of discovering certain truths, which to me at least were new. For being resolved to examine *Humane Understanding*, and the ways of our knowledge, not by other's opinions, but by what I could from my own observations collect myself, I have purposely avoided the reading of all books that treated any way of the subject, that so I might have nothing to bias me any way, but might leave my thought free to entertain only what the matter itself suggested to my meditations" (pp. 177–178).

This letter, which is the most important in the collection for the understanding of the *Essay*, reveals that the memorable discussion which gave occasion to the *Essay* very probably occurred in 1681 or 1682 and not in 1670–1671, as stated by Lady Masham in the sketch of Locke's life she sent to Le Clerc, or in 1673, as Tyrell noted in the margin of his own copy of the *Essay*.[1]

Nearly a year later, December 31, 1687, Locke writes from Amsterdam that Pembroke is so well satisfied with the abridgments of some parts of the *Essay* which he has seen that he desires to see the whole discourse, and requests Clarke to turn over to the Earl his own copy, "and if you desire another you shall not fail to have one, if it be not printed, which I am apt to expect it will now be ere long" (p. 231).

On December 16, 1688, Clarke writes after a conference with Pembroke about the *Essay:* "That whatever he [Pembroke] had to say upon that subject was in no sort any objection either to the

[1] See Dr. Rand's *Biographical Study*, p. 28.

notions in your book, or the reasons made use of to support them, but purely relating to the repetitions and other small errors therein which you have already corrected, and therefore he desires you to proceed in your design of publishing it, with the first opportunity, as a performance that will not only exceedingly oblige him, but all the considering and learned part of mankind" (p. 279).

The book is beautifully printed, equipped with a full index, and embellished with portraits of Locke, Edward and Mrs. Clarke, and Locke's "wife," their daughter, Betty.

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JOURNALS AND NEW BOOKS

MIND. Vol. XXXVII, No. 147. Mr. Bertrand Russell's *Outline of Philosophy: H. A. Prichard.* Spinoza's Conception of Eternity: *H. F. Hallett.* Cook Wilson's View of Judgment: *Richard Robinson.* The Notion of Duty (II): *W. D. Lamont.* Discussions—The Theory of Types: *Paul Weiss; Cosmic Evolution: J. E. Boodin;* The Infinite Regress of Proof: *F. C. S. Schiller.*

AUSTRALASIAN JOURNAL OF PSYCHOLOGY AND PHILOSOPHY. Vol. VI, No. 2. Self: *W. Anderson.* Some Aspects of Propaganda: *E. Beaglehole.* Unification or Self-Government: *F. A. Bland.* Summarized Reports of Distributions and Inter-correlations of Binet and Performance Test-Values Obtained from Sub-normal Children in a Mental Survey: *E. Morris Miller.* Some New Apparatus for the Psycho-Galvanic Reflex Phenomenon: *C. E. W. Bellingham, S. L. Smith,* and *A. H. Martin.*

REVUE DE METAPHYSIQUE ET DE MORALE. 35e Année, No. 3. En marge de M. Brunschvicg: *D. Parodi.* La sagesse de Goethe et la civilisation de l'Europe moderne (*suite et fin*): *R. Bertholot.* Sur les limites de l'interprétation sociologique de la morale: *G. Mauchaussat.* L'âme primitive, d'après M. Lévy-Bruhl: *Ch. Blondel.* École unique et éducation intégrale: *J. Delvolvé.* La pensée et l'action: *P. Dugas.*

REVUE D'HISTOIRE DE LA PHILOSOPHIE. 2e Année, Fasc. 3. Scolastique musulmane et scolastique chrétienne (1er article): *L. Gauthier.* A quelle date Descartes a-t-il écrit la "Recherche de la Vérité?": *G. Cantecor.* La conversion de Renouvier au finitisme (2e et dernier article): *R. Le Savoureux.* Editions, traductions, et commentaires.

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THE NEW SCHOLASTICISM. Vol. II, No. 3. The Bergsonian Conception of Science and Philosophy: *R. G. Bandas.* The Problem of Substance (II): *Augustine Osgniach.* Chronicle: The Philosophical Movement in Germany: *Joseph Engert.*

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PSYCHOLOGICAL BULLETIN. Vol. 25, No. 5. General Reviews and Summaries—Special Artistic Talent: *N. C. Meier.* Studies in the Psychology of Children's Drawings: *F. L. Goodenough.* Tests and Measurements in Music: *J. Kwalwasser.* Psychological Necrology (1903–1927): *E. G. Boring.* (No. 6) General Reviews and Summaries—Psychology in Industry: *M. S. Viteles.* The Thyroid Gland: *J. G. Rockwell.*

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NOTES AND NEWS

TO THE EDITORS OF THE JOURNAL OF PHILOSOPHY:

The collected works of Charles Saunders Peirce are shortly to be published by the Harvard University Press. A detailed biography is also in preparation. Will not all persons who happen to be in possession of letters, biographical material, or papers, by or concerning Charles Peirce, be so kind as to communicate with the undersigned?

Acknowledgment will be made and where desired letters or papers will be returned.

CHARLES HARTSHORNE

HARVARD UNIVERSITY